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Open access movement in the scholarly world: Pathways for libraries in developing countries

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Abstract

Open access is a scholarly publishing model that has emerged as an alternative to traditional subscription-based journal publishing. This study explores the adoption of the open access movement worldwide and the role that libraries can play in addressing those factors which are slowing its progress within developing countries. The study has drawn upon both qualitative data from a focused literature review and quantitative data from major open access platforms. The results indicate that while the open access movement is steadily gaining acceptance worldwide, the progress in developing countries within geographical areas such as Africa, Asia and Oceania is quite a bit slower. Two significant factors are the cost of publishing fees and the lack of institutional open access mandates and policies to encourage uptake. The study provides suggested strategies for academic libraries to help overcome current challenges.

Keywords

Institutional repositories; open access declarations; open access initiatives; open access journals; open access models; open access movement; scholarly publishing

1. Introduction

Scholarly publishing plays a significant role in the dissemination of research work and its findings [1]. From the beginning of this century, the traditional model of scientific communication has undergone profound changes [2]. Before the invention of the Internet, publishers and academic societies completely dominated the scholarly communication system. However, the invention and wide use of the Internet and information communication technologies has entirely changed the landscape of scholarly publishing [3]. On the one hand, there has been a marked increase in the number of research journals [4]. On the other hand, because of the increase in journal prices and shrinking library funds, libraries have not always been able to take advantage of this new research [5]. Ongoing budget constraints have forced libraries to unsubscribe from a number of journal subscriptions, which ultimately has restricted researchers' access to scientific literature [6]. Moreover, because most research is financed by public taxes, people want to access research quickly and with no payment restrictions. In response to these developments, a movement emerged that supports the publishing of research through open access channels [7].

At present, two principal types of publishing models exist for scholarly writings, that is, the traditional form of publishing and open access publishing. Open access is an emerging publishing model that has gradually prevailed in the scholarly world [7,8], principally because of its objective to make scholarly information accessible to the entire scientific community free of cost. Moreover, open access possesses the capacity to let scholars worldwide add to the development of human knowledge, thereby helping to maximise new discoveries and further innovation. This is a marked contrast with more traditional publishing models which confine knowledge to a limited community, thus limiting opportunities

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to enhance knowledge and apply it in ways that could solve real problems. In other words, the open access movement is striving to bridge the so-called digital divide by minimising access and knowledge issues [9]. It has created a remarkable change in the behaviour of researchers, publishers and funders as they have adopted this new publishing model [10]. At present, an increasing number of libraries, institutions and governments globally are supporting the open access movement [11,12].

While the open access model has been steadily making progress internationally, there is evidence that some developing countries are struggling to gain traction [1,13–16]. This study, therefore, attempts to assess the comparative uptake of the open access model in developing countries, along with the principal factors that are negatively affecting that uptake. It discusses the key role that libraries can play in addressing these challenges. Although there is no single, agreed definition of the term 'developing country', the authors drew upon two major sources to clarify this widely used classification. According to World Population Review [17], a developing country is generally defined as 'one with a low level of industrial and/or economic development, which leads directly or indirectly to social, political, economic, and environmental challenges that significantly impede quality of life in that country'. For its part, drawing upon the International Monetary Fund's classification system, WorldData.info [18] lists 152 developing countries, which constitute about 85% of the world's population. These countries comprise all of Central America, South America and Africa, almost all Asian countries, and numerous other island states.

1.1. Research objectives

The broad objective of this study was to assess the comparative uptake of the open access model in developing countries by examining overall statistics for open access adoption worldwide. The specific objectives of the study were to:

1. Identify the major benefits of open access to scholarly communication.
2. Analyze the adoption of the open access model worldwide.
3. Examine the major factors which are adversely affecting the uptake of open access, particularly in developing countries.
4. Propose library strategies to increase the uptake of the open access model within developing countries.

1.2. Design of the study

This study is primarily based on a 'narrative literature review', that is, 'published materials that provide examination of recent or current literature' [19]. The narrative type of review of the literature method was used in this study to better understand and integrate the body of literature on open access. McGaghie [20] asserts that in such type of literature reviews, the criteria for article inclusion and exclusion are typically based on the reviewers' judgement. According to Rowley and Slack [21], narrative review has multifaceted goals, one of which is to help readers grasp the terminology and theoretical concepts associated with a given topic. While typically narrative, it is not necessarily comprehensive. According to Grant and Booth [19], this research method has the advantage of 'seek[ing] to identify what has been accomplished previously, allowing for consolidation, for building on previous work, for summation, for avoiding duplication and for identifying omissions or gaps' (p. 97).

A narrative review of the literature on open access was undertaken to address the objectives regarding the major benefits of open access to scholarly communication and the principal factors adversely affecting its uptake. While the analysis of the adoption of the open access model worldwide was carried out by analysing the openly accessible data regarding open access books, theses, journals, repositories and policies and mandates from major sources, including the Open Directory of Open Access Repositories (OpenDOAR), Registry of Open Access Repositories (ROAR), Registry of Research Data Repositories (Re3data), Directory of Open Access Journals (DOAJ), Registry of Open Access Repository Mandates and Policies (ROARMAP), Directory of Open Access Books (DOAB) and Open Access Theses and Dissertations (OATD).

1.2.1. Search strategy. This research is a part of an MS thesis; therefore, in phase 1, the authors evaluated the contents of a bibliography compiled by the lead author for his thesis for a Master of Science in Library and Information Science. As some of the objectives of the thesis were related to the objectives of this study, some literature was taken from the thesis. In phase 2, the authors updated their literature review by searching Google Scholar, using the key terms such as 'open access movement', 'open access models', 'open access initiatives', 'open access declarations', 'open access journals', 'predatory publishing', 'predatory journals', 'fake journals', 'article processing charges', 'advantages of open access',

'challenges and opportunities to open access', perceptions about open access, open access to scholarly literature, scholarly communication crisis, role of libraries in open access and 'institutional repositories'. A total of 122 sources are cited in this article which were included in the review. In the third phase, the authors collected openly accessible data of open access books, theses, journals, repositories and policies and mandates from major sources, including the OpenDOAR, ROAR, Re3data, DOAJ, ROARMAP, DOAB and OATD. The purpose was to meet the study's second objective by analysing the growth of open access journals, institutional repositories and mandates at a global level and by determining, where possible, the geographical distribution of participating institutions.

1.2.2. Inclusion criteria. The researchers selected only those documents for the review that were considered most relevant to the objectives of the study. Furthermore, documents that were published in the English language were only selected for the review. The types of documents selected for the review were research articles, conference papers, books, book chapters, research reports and websites.

2. Review of the literature

The review of the literature has been divided into three main sections. In the first section, the authors present a brief overview of the open access movement which explores the range of applicable definitions and models, as well as the response over time from commercial publishers. The major advantages of open access are also presented. In the second section, the authors have examined research on the principal aspects of concern regarding open access. In the third section, the authors have briefly examined the role of libraries in advancing open access from the perspective of developing countries.

2.1. An overview of open access

2.1.1. Definition. Before examining the details of this research, it is essential to define the basic concepts of open access. Institutions and individual scholars have issued jointly various key statements, including the following.

The Budapest Open Access Initiative (BOAI) [22] defines open access as follows:

> by open access to peer-reviewed research literature, we mean its free availability on the public internet, permitting any users to read, download, copy, distribute, print, search, or link to the full texts of these articles, crawl them for indexing, pass them as data to software, or use them for any other lawful purpose, without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. The only constraint on reproduction and distribution, and the only role for copyright in this domain, should be to give authors control over the integrity of their work and the right to be properly acknowledged and cited.

The Bethesda and Berlin declarations jointly define open access in a similar way: A publication can be open access, if the copyright holder(s) of a work permit the users 'to access, copy, use, distribute, transmit and display the work publicly and to make and distribute derivative works, in any digital form for any responsible purpose, subject to proper attribution of authorship' [23,24]. In general, digital content that is available online without any price or consent restrictions can be referred to as 'open access'. Moreover, any kind of content can be digital: whether it is in the form of texts, data, images, audio, video, multimedia and executable code. However, the term 'open access' was originally conceived by researchers in the context of removing access barriers specifically to research [25]. The potential impact of so-called 'Black Open Access' on these foundation concepts is discussed in a following section separately.

2.1.2. Key statements and declarations. Although the BOAI is regarded in the literature as the foremost declaration to introduce the concept of open access, the idea of open access was already under discussion in other conferences [26]. At the 1999 Santa Fe Convention, the Open Archives Initiative proposed a framework that would assist in the creation of open access e-print archives. Shortly afterwards, in 2001, the Open Society Foundation (OSF) organised a conference in Budapest to discuss potential impacts of open access on scholarly research. This conference established the foundation for the succeeding BOAI, which was one of the defining moments of the then emerging open access movement. Certainly, BOAI was the foremost global declaration to confirm a commitment towards open access [7]. It was the first international declaration that really accelerated the open access movement. The agenda of this declaration was to collectively support worldwide efforts to make research freely accessible through the Internet. At present, 6141 individuals and 976 organisations worldwide have signed the BOAI [22].

Soon after the BOAI, several other international declarations also emerged in support of the open access movement. One of these declarations was the 'Bethesda Statement on Open Access Publishing', which was drafted on 11 April 2003, at Howard Hughes Medical Institute, Maryland [24]. On 22 October 2003, the Berlin Declaration [23] was announced in support of open access from sciences and humanities researchers. There are additional declarations which have been adopted by various organisations and institutions that support open access principles. Some of these include the 'IFLA Statement on Open Access to Scholarly Literature and Research Documentation', World Summit on the Information Society's 'Declaration of Principles', 'Washington DC. Principles for Free Access to Science', 'Scottish Declaration of Open Access', 'Australian Research Information Infrastructure Committee Open Access Statement', 'Access to Research Publications: Universities UK Position Statement', Group of Eight's 'Statement on Open Access to Scholarly Information' and 'Messina Declaration'.

Recently, Björk and Korkeamäki [27] have discussed,

> Plan S 47, which has been gathering pledges from leading research funders from several countries to push for a more rapid adoption of open access. A recent important development is also the push of several large library consortia to force major publishers to repackage their big subscription deals to include automatic APC payments for articles published by their faculty in hybrid journals.

At time of writing, Plan S continues to be discussed in the literature as an important vehicle for advancing the adoption of open access [28].

2.1.3. Open access models. Open access has two main types of models: gold and green.

Gold open access, or the Gold (en) Road, refers to open access journals [29]. Gold open access has three types: (1) Direct Gold, (2) Delayed Gold and (3) Hybrid Gold. Direct Gold points to those journals that offer all their articles free of cost to the readers immediately after publication [30]. Some subscription-based journals also convert their articles to open access after a specified period; this is called delayed open access [31]. On the other hand, subscription-based journals offer authors a choice to pay the Article Processing Charges (APCs) of their particular article(s) to make them freely accessible to readers; this is called hybrid open access [32].

Green open access, or the Green Road, refers to the self-archiving of a (pre-print or post-print) copy of the article(s) or scholarly material(s), on the author's own website or in an institutional repository [33]. 'The pre-print is the author's manuscript version of the publication that has been submitted to a journal for consideration of publication' [34]. One aspect that authors need to consider while self-archiving their article(s) is the journal's copyright rules [35]. Through green open access, the authors enjoy the privilege of preservation and free access services [36].

2.1.4. Commercial publishers' response. Initially, open access was treated as a controversial issue and was confronted with protests by commercial publishers worldwide [37]. However, at present, the scenario has changed markedly and a majority of commercial publishers, including Nature Publishing Group, Sage, Elsevier, Springer, Wiley and Emerald, have incorporated open access models in their traditional publishing system [38]. These publishers have introduced new open access journals or offered open access options for their existing subscription journal titles called 'hybrid open access'. Most of these journals are either funded through sponsorship or by APCs [10]. A recent study of Björk [39] reports a significant increase in the number of hybrid open access journals, that is, from 2000 in 2009 to almost 10,000 in 2016.

Springer adopted the open access model by launching SpringerOpen [40] in June 2010. As of 2021, SpringerOpen includes more than 200 peer-reviewed open access journals. Elsevier, one of the largest publishing groups, is now one of the world's largest open access journal publishers [41]. As of February 2021, there were 985 fully open access journal titles and over 250,000 articles indexed in ScienceDirect and more than 1850 hybrid open access journals. The aggregate total of direct open access and hybrid open access journals indexed in ScienceDirect has reached 2800 [42]. Since 2013, Emerald [43] has been offering a range of open access options to its prospective authors and their sponsoring bodies to publish their books, handbooks and articles. OnlineOpen is a Wiley [44] hybrid open access option available to prospective authors for over 1300 journals. Sage publishes over 950 research journals on various subjects. As of February 2021, out of these 950 journals, 170 were accessible to their readers through Gold open access [45].

2.1.5. Advantages of open access. The advantages of open access have been extensively documented in the literature (refer Figure 1). Open access to scientific literature is of interest to all scholars, particularly scholars who work in developing countries [46] where academic, medical and research institutions tend to have limited resources, and libraries generally face the underfunding of subscriptions to research literature [47,48]. Joshi et al. [49] report open access material is free of copyright and licencing restrictions. Open access is also useful in creating awareness among the public about science

Figure 1. Advantages of open access.
Source. https://aoasg.org.au/resources/benefits-of-open-access/ [CC-By licence for this image]

[50]. The fundamental principle of open access is that wider access to publicly funded scientific research is more democratic and is essential for knowledge creation and distribution [51]. Mashroofa [52] notes that open access is equally useful for authors and readers, as it allows every stakeholder within the scientific community to use and re-use information.

Xia and Nakanishi [53] and Piwowar et al. [5] point to one of the advantages of open access articles being that they are cited more frequently than subscription-based articles or articles published in print format. Similarly, articles of those authors who self-archive their article(s) are more cited compared with articles in journals that are not open access. Laakso et al. [54] and Willinsky and Moorhead [31] assert that open access journals have more scientific impact because of their increased citations. Moreover, authors are the main beneficiaries of the wider visibility of their publications disseminated through open access, as it helps them in wide readership, citations and acknowledgement by other authors. According to Lee-Hwa et al. [55], open access repositories, for example, create an 'environment for scholarly inter-communication', which helps to establish recognition for authors. Eve [56] affirms that open access is also beneficial to libraries as it is a solution to the so-called crises of 'price and permission'. Björk [57] goes so far as to describe open access as 'almost inevitable, because it is the optimal solution, and [sic] the best interest of all stakeholders in the process'. He does, however, acknowledge the relatively slow progress in achieving optimal adoption.

2.2. Concerns about open access

2.2.1. Black open access. According to Piwowar et al. [5], the term 'Black Open Access' refers to 'Articles shared on illegal pirate sites, primarily Sci-Hub and LibGen' (p. 4). They go on to say:

> Although Björk [58], labels these articles as a subtype of open access, the literature has nearly no support for including Sci-Hub articles in definitions of open access. Given this, we exclude Sci-Hub and LibGen content from our definition of open access.

That said, there is no denying the impact that these illegal resources are having on access to content, especially in low- and middle-income countries [14,59]. However, some researchers have described these resources in quite negative terms. For example, Machin-Mastromatteo et al. [60] have described Sci-Hub as a 'threat to publishers and open access'. González-Solar and Fernández-Marcial [61] mention 'systems that overcome the limits of legal access to scientific publications, standing apart from the open access movement'. Buehling et al. [62] refer to Sci-Hub and similar services as 'copyright circumvention mechanisms'.

Notwithstanding the varied opinions as to whether Black open access should be labelled as 'open access', the authors believe that while the concept highlights fundamental flaws with the current publishing model(s), Black open access is

not in the 'spirit' of the original intent of the open access movement. For that reason, the authors have not included it in the current discussion.

2.2.2. Fake publications and editorial boards. Although open access appears to provide many prospective advantages to society [46], questions regarding the quality of open access publications also exist. Of concern is the prevalence of 'fake' publications, that is, publications that exist but under false pretenses. For instance, the rise of predatory journals, that is, journals that demand authors pay a publishing fee while providing substandard peer-review, copy-editing, and indexing services, is a serious concern that can severely damage the reputation of open access journals [46,57,63,64]. The business model for these journals is Gold open access (as described above); although publishing fees are charged to the authors after their manuscripts have been accepted, the articles are freely available online.

As Storebø et al. [65] have observed, a major concern is that academics and researchers frequently receive emails requesting that they submit a manuscript to a predatory open access journal. Authors who are either relatively inexperienced or feeling under pressure to 'get published' may view these offers as worthwhile. Of particular relevance to this study is the finding by Perlin et al. [66], that the authors who have published in or cited from predatory journals tend to be young, inexperienced scholars from developing countries. The most affected geographical areas seem to be Africa, particularly Nigeria and South Africa, and Asia, particularly China, India, Pakistan and Malaysia [67].

Memon [68] discusses hijacked as another important category of fake journals. Whereas predatory journals publish articles for money, hijacked journals steal the identity of original journals through fake websites to trap writers. The impact that this has had on both the reliability of published research and the reputation of unsuspecting researchers has led to continuing efforts to improve their detection [69–71].

Given the importance of the role of journal editors, an allied concern has arisen from the creation of fake editorial boards, which are normally associated with predatory journals. The creation of such entities generally happens in one of two ways: either the journal lists prestigious academics unbeknown to them or it aggressively recruits academics [72]. In both cases, the objective is to give the impression of a legitimate-looking editorial board to mislead prospective contributors. There is evidence that fake editorial boards as well as the non-acceptance of open access journals by universities are among the issues that are prevalent in most countries of the world [73,74].

Given the existence of these fake scholarly initiatives, there is an ongoing, concerted effort within the scholarly communication community to combat this trend. The 'Think. Check. Submit' campaign has been heavily promoted as a way in which to educate scholars how to assess the legitimacy of journals [67]. Librarians use the annual Open Access Week event to focus their clients' attention on open access and related topics [75]. Editorials in reputable journals continue to raise the awareness of their readership as to the issues associated with fake publications [76–78]. Else and Van Noorden [79] have recently chronicled the fight of publishers against what they refer to as 'fake-paper factories'.

2.2.3. Article Processing Charges. Another major concern is the APCs [80], which is also referred to as 'Publication Fee' [81]. Hybrid open access journals and some Gold open access journals demand authors pay the corresponding APC before the publication of their article(s) [29]. Normally, the APCs are paid through either research grants, university funds, through offsetting agreements, or, in some cases, by the authors themselves. Beaudry et al. [82] provide a list of standard payment approaches used by universities. However, these publication charges can present a serious hurdle for authors, especially from developing countries [1,13–16,83,84]. Björk and Solomon [85] reported that whereas only 12% of European researchers had paid the APCs themselves, 39% of the funding in developing nations came from personal funds. For their part, Nabyonga-Orem et al. [86] have highlighted the specific example of African researchers' lack of funding, and Jain et al. [87] have identified corresponding challenges for Indian researchers. This then can lead to a potentially negative impact on the relevant universities and funding agencies in those countries, as well as their overall research profile.

This challenge is not, however, limited to developing countries. Burchardt [88], for example, reported that 30% of authors in Danish journals were not affiliated with a research institution and therefore were not eligible for funding to cover any APC charges, if required. In a US study, Halevi and Walsh [89] reported that 16% of faculty pays APCs using personal funds. In addition, libraries have chronicled their challenges in helping to subsidise these costs as part of their collection development policy and/or taking responsibility for using their payment systems to manage the relevant financial processes on behalf of the organisation [90,91].

Unlike in the case of fake publications, attempting to address the issues associated with APCs is far more complex. For example, Plan S, launched by cOAlition S (a consortium of research funders), requires authors to publish studies funded by their public grants in open access journals or platforms from 2021 [27]. According to Asai [92], such initiatives have increased the demand for open access journals, which may lead to an increase in APCs. This assertion is also supported by Siler [93].

Finally, there is concern about a potential loss of international reputation by publishing with an open access provider rather than with a more traditional publisher. Coupled with this is the apprehension that an author's intellectual content may be used for commercial purposes. Nobes and Harris [94] have highlighted these issues in their study of low- and middle-income countries.

2.3. Role of libraries in open access

Librarians have been discussing the role of libraries in advancing open access for several decades. Moreover, in the mid to late-2000s, lengthy bibliographies were being created specifically on 'libraries and open access', for example, Bailey [95]. While an in-depth analysis of the relevant literature is beyond the scope of this study, it is useful to briefly examine what has been written specifically in the context of developing countries.

Kaba and Said [3], whose study surveyed faculty members at Al Ain University of Science and Technology (AAU) in the United Arab Emirates (UAE) on their awareness and use of open access resources, highlighted the key role of the AAU Library in providing these resources. Jain and Akakandelwa [96], for their part, have discussed the challenges that academic African libraries face within their institutions, which include the slow acceptance of open access resources and the resistance to change.

Boufarss and Laakso [47] have reported on open access among higher education institutions in the UAE. Librarians self-identified as the stakeholders for whom open access had the highest importance strategically. And yet, the researchers' survey reported that only about 17% of the respondents provided any formal training about open access. They concluded that considerable improvement was needed in areas such as awareness, policies and best practice if open access was to achieve its potential among the UAE. In their survey of researchers in low- and middle-income countries, Nobes and Harris [94] have briefly mentioned the role of academic libraries in services such as providing open access resources and institutional repositories. However, they have concluded that much more work needs to be directed at raising awareness of aspects such as licencing, open data and predatory publishing.

More recently, Ukwoma and Onyebinama [97] have investigated librarians' efforts in federal and state universities in Nigeria to facilitate access to open access resources. While their findings indicate that librarians are aware of open access resources, the major challenges they face in giving users access to these resources are 'lack of metrics and evidence to demonstrate the value of free content' (p. 481).

In summary, the relatively frequent analysis in the literature of how widely and rapidly the open access movement is being adopted worldwide has highlighted steady progress by the international community, although exposing, at the same time, difficulties being experienced within the developing world. While there have been studies on the efforts of specific libraries, there has been no recent study which examines, from a broader perspective, both the challenges experienced by researchers and the supporting role that libraries can specifically play. The research by Bawack and Nkolo [98] is limited to Cameroon, despite the title of their article. This study attempts to bridge the gap in knowledge by collating a range of examples to help libraries formulate targeted strategies that would increase the uptake within their institution, regardless of geographical location within the developing world.

3. Results of the study

In this section, the authors report on the data derived from analysing major open access sources, with particular reference to the geographical distribution of participating institutions, as well as two major comparative studies.

3.1. Adoption of the open access model worldwide

Various open access initiatives have been undertaken at different levels to provide free access to scholarly information. Some of the major international initiatives are discussed as follows.

3.1.1. Directory of Open Access Journals. DOAJ traces its origin back to 2003, when the first Nordic Conference on Scholarly Communication took place at Lund University, Sweden. It aims to promote the educational and research activities at a global level by providing free access to all open access research journals. As of February 2021, DOAJ [99] had expanded its coverage from 300 journals to 15,874 journals, representing 124 countries and 80 languages. The number of journals in DOAJ is constantly rising at a regular rate (see Figure 2). DOAJ currently receives financial and managerial support from different libraries, publishers and editors worldwide, which assists the organisation in running and

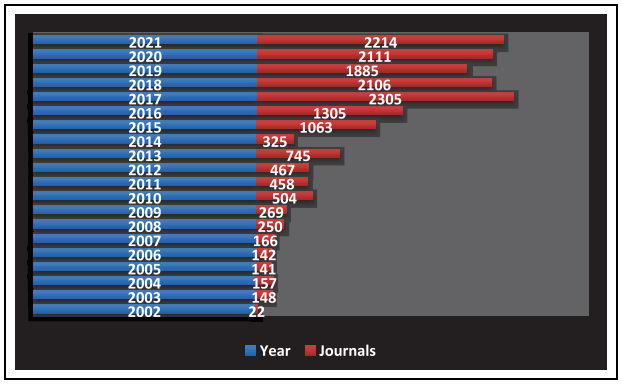

Figure 2. Annual growth of journals in DOAJ (2021).
Source: https://doaj.org/

looking after the operational matters. This clearly affirms the commitment of all these stakeholders towards the development of open access movement at a large scale [100].

3.1.2. Development of open access journals worldwide. The growth of open access is traditionally measured through the number of open access journals and number of subject and institutional repositories that have been developed, which can produce divergent results depending upon the source [101]. As a major resource of open access journals, DOAJ is generally used, however, as the benchmark for reporting on overall growth in open access journals. As mentioned previously, data retrieved from this resource in February 2021 identified 15,874 open access journals published throughout the world. Figure 3 demonstrates that Indonesia is leading in the world with 1777 open access journals, whereas United Kingdom secures second position with 1726 journals. Brazil, Spain and United States secure third, fourth and fifth positions, respectively, with 1604, 875 and 818 open access journals.

3.1.3. Directory of Open Access Repositories. The second key international initiative in support of the open access was introduced in 2003. This initiative is referred to as OpenDOAR, which is an international directory of all institutional and subject repositories. Initially, OpenDOAR was jointly developed by the University of Nottingham, UK and Lund University, Sweden. However, at present, it is maintained by SHERPA Services, based at the Centre for Research Communications at the University of Nottingham. As of July 2021, OpenDOAR provides details about 5675 repositories, representing 119 countries. The statistics of OpenDOAR [102] shows a regular annual increase in the development of repositories worldwide (see Figure 4).

3.2. Development of institutional repositories in the world

Open access repositories have formed an important part of open access implementation since the beginning of the open access movement [85]. An analysis of the global growth of open access repositories from 2005 to 2012 using OpenDOAR data reported a 1660 percent rise of repository numbers from 128 in December 2005 to 2253 in December 2012 [103]. OpenDOAR is generally used as a major resource of open access repositories. As of February 2021, data retrieved from this resource identified 4495 open access repositories developed throughout the world. Figure 5 demonstrates that the increase in open access repositories development is still in progress, especially in countries within Europe, Asia and South America. On the other hand, countries within Africa, North America and Oceania are a bit slower with their open access repositories' development.

A further analysis of the data retrieved from OpenDOAR demonstrates that the United States leads the world with 922 repositories, whereas Japan secures second position with 681 repositories. United Kingdom, Germany and Peru secure third, fourth and fifth positions, respectively, with 324, 293 and 189 repositories (see Figure 6). As in Lee-Hwa et al.'s [55] results, whereas Europe and North America account for the overall largest number of repositories, geographical areas such as Africa is underrepresented.

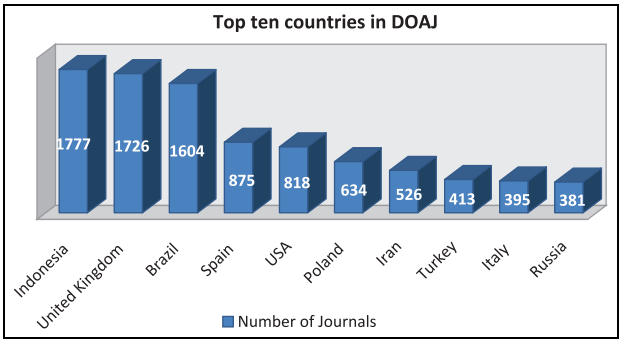

Figure 3. Top 10 countries in DOAJ (2021).
Source: https://doaj.org/

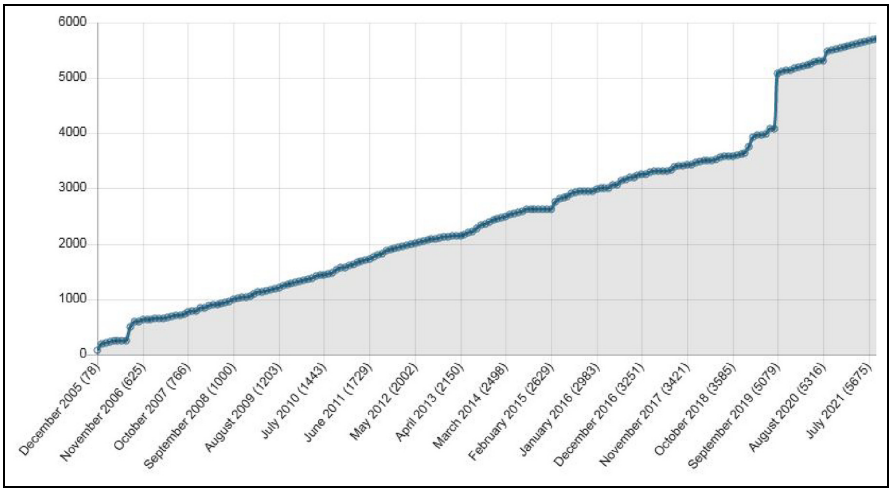

Figure 4. Annual Growth of Repositories in OpenDOAR.
Source: https://v2.sherpa.ac.uk/view/repository_visualisations/1.html [Licence to use: CC BY-NC-ND 4.0]

3.2.1. Registry of Open Access Repositories. ROAR is another major international resource for identification of institutional and subject repositories. ROAR [104] was developed at the University of Southampton in 2003 by its EPrints Services. As of 2021, 4725 institutional repositories were registered in this resource (see Figure 7).

3.2.2. Registry of Open Access Repository Mandates and Policies. ROARMAP is an international resource that identifies the growth of open access mandates and policies adopted by universities, research institutions and research funders worldwide. This resource was developed by a team at the University of Southampton in 2003. The signatories of the open access policies and mandates recommend their researchers, faculty members and students to publish their research in open access journals or deposit the final version of their articles into open access institutional or subject repositories [105]. The statistics for this resource identify 1114 open access policies and mandates worldwide, with this number constantly increasing (see Figure 8). Further analysis of the data retrieved from ROARMAP demonstrates that the continent of Europe leads the world with 710 open access policies, whereas North America secures second position with 186 policies. Asia, South America, Oceania and Africa secure third, fourth, fifth and sixth positions, respectively, with 84, 56, 42 and 36 policies which clearly signify that countries in the Global South are lacking in the development of open access policies and mandates (see Figure 9).

3.2.3. Registry of Research Data Repositories. Research data is an important element in the research process and researchers have always been concerned in managing their research data. Consequently, many educational and research institutions

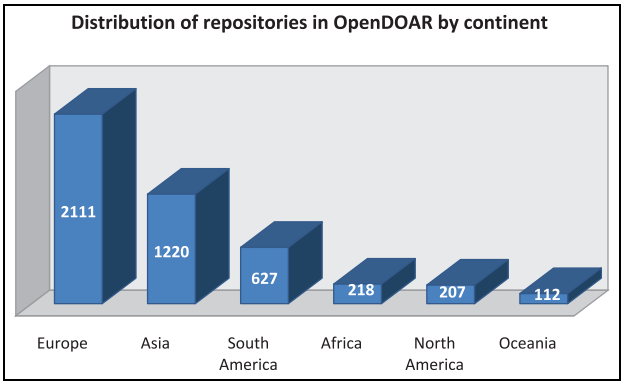

Figure 5. Distribution of repositories in OpenDOAR by continent (2021).
Source: https://v2.sherpa.ac.uk/view/repository_visualisations/1.html

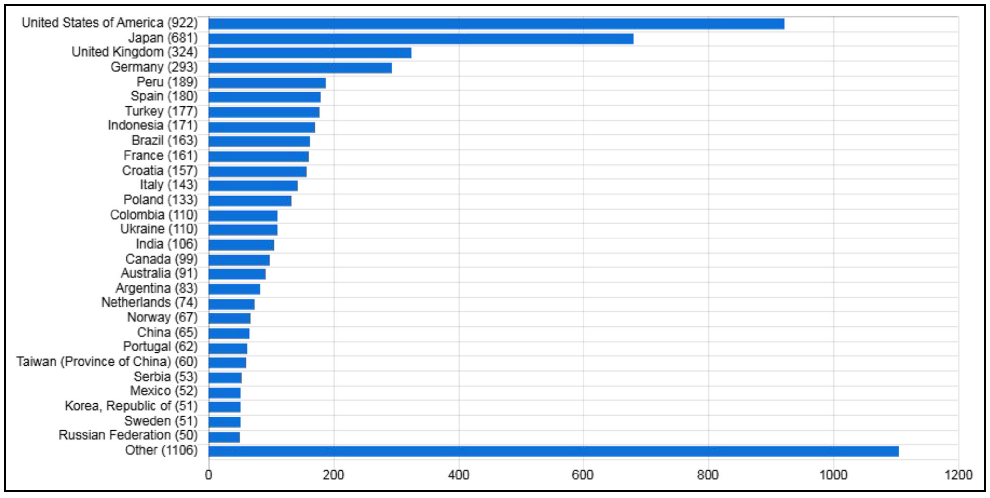

Figure 6. Growth of repositories in OpenDOAR by country.
Source: https://v2.sherpa.ac.uk/view/repository_visualisations/1.html.

have developed research data repositories to address this issue. Re3data is a major open access resource that identifies the research data repositories developed throughout the world. It guides researchers to identify an appropriate data repository for the submission of their research data. Re3data was launched in 2012 in collaboration with the German Research Foundation, Humboldt University and Purdue University [106]. The green colour shown in Figure 10 depicts the representation of data repositories in almost all areas of the world. However, it is quite apparent in the picture that a majority of the countries in the Global South are lacking in the development of research data repositories as a significant portion of the map in Global South is coloured in blue highlighting non-development of data repositories in these countries.

3.3. Dynamics of the open access initiatives in the world by continent

In Table 1, a comparison of data between four different open access databases has been presented on a continental level. The analysis of this data shows that the uptake of open access initiatives has been quite satisfactory in Europe, Asia, South and North America continents. On the other hand, countries within Africa and Oceania continents are lacking in the publishing of open access journals, development open access repositories, research data repositories and designing open access policies and mandates. These statistics emphasise that countries in Africa and Oceania continents need to concentrate on the development of open access initiatives.

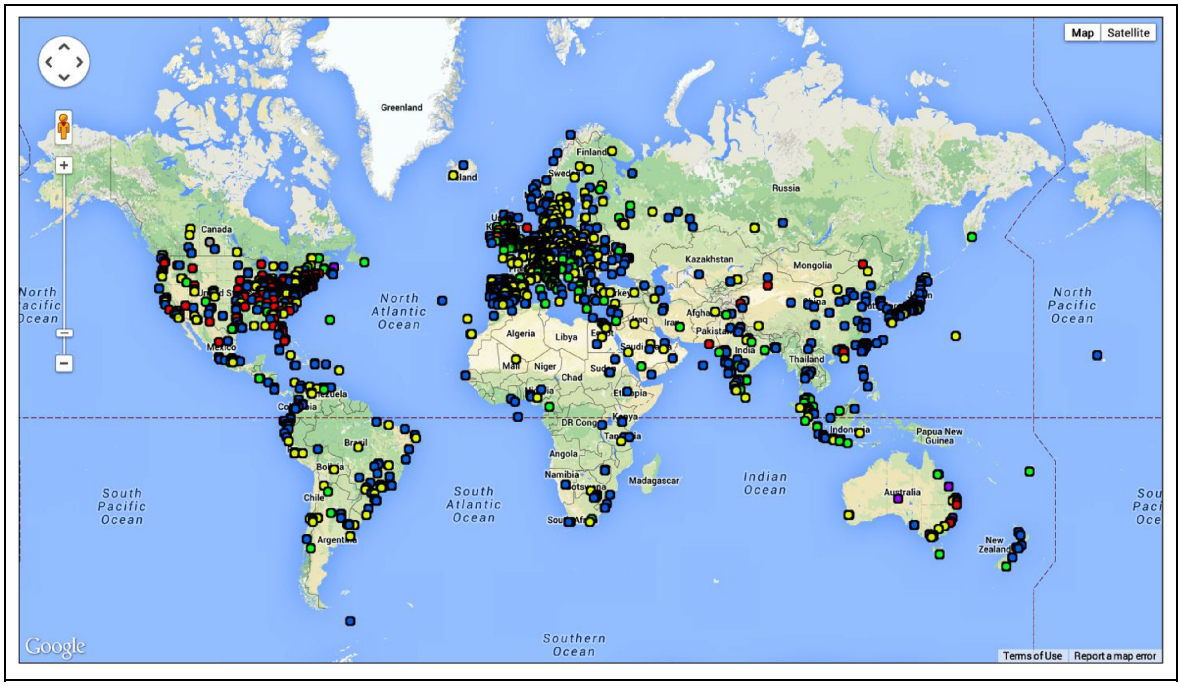

Figure 7. Map of institutional repositories worldwide, 2021.
Source: https://sites.google.com/site/zibo618ir/introduction/examples

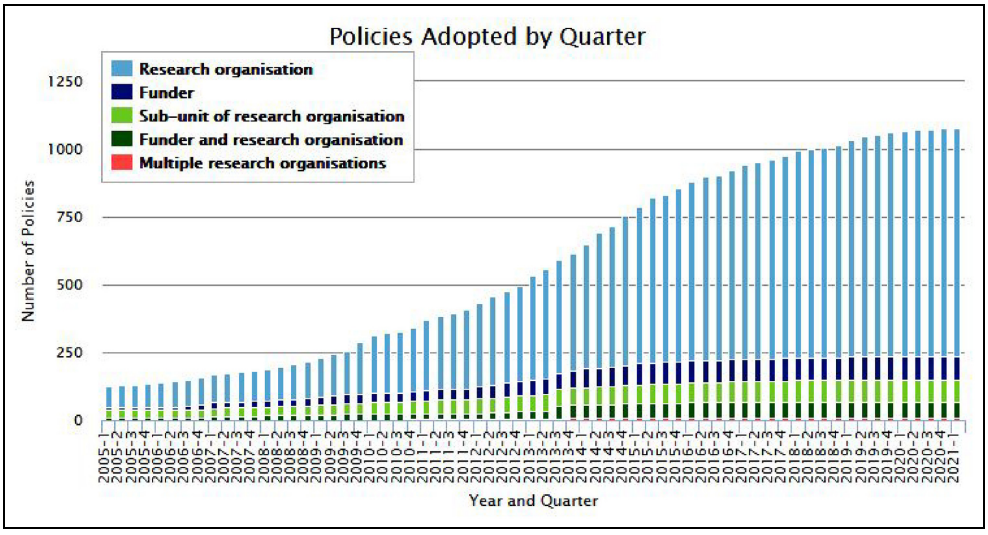

Figure 8. Annual growth of policies in ROARMAP (2021).
Source: https://roarmap.eprints.org/view/country/un=5Fgeoscheme.html

3.4. Directory of Open Access Books

DOAB is a service of the OAPEN Foundation, a non-profit organisation, located in Hague, Netherlands. It was made functional in 2012 with the principal motive to boost the free availability of open access books in electronic format. DOAB was developed in collaboration with Lars Bjørnshauge and Salam Baker Shanawa, who also developed the DOAJ. As of February 2021, DOAB [107] provides access to 34,386 books and book chapters from 413 publishers around the world.

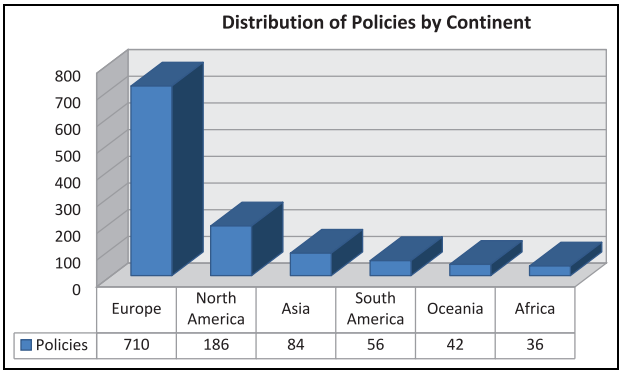

Figure 9. Distribution of policies by continent (2021).
Source: http://roarmap.eprints.org/view/country/un=5Fgeoscheme.html

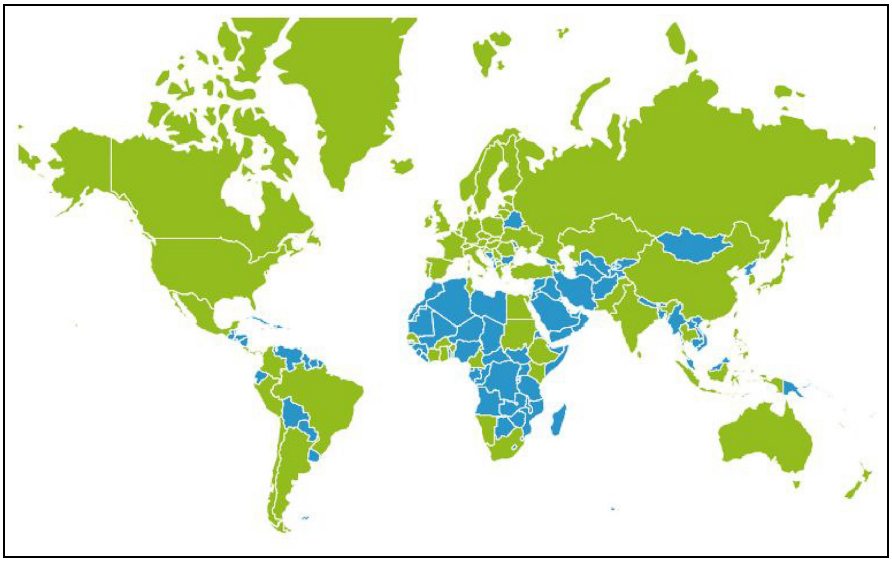

Figure 10. Map of data repositories worldwide (2021).
Source: https://www.re3data.org/browse/by-country

Table 1. Dynamics of the open access initiatives in the World by Continent.

Continent	DOAJ	OpenDOAR	ROARMAP	Re3Data	Total
Europe	8187	2111	710	1456	12,464
Asia	5482	1220	84	304	7090
South America	2836	627	56	43	3562
North America	1581	207	186	1573	3547
Africa	456	218	36	35	745
Oceania	156	112	42	116	426

DOAJ: Directory of Open Access Journals; ROARMAP: Registry of Open Access Repository Mandates and Policies.

3.5. Open Access Theses and Dissertations

OATD is another international initiative that aims to provide open access to graduate-level theses and dissertations published by various universities of the world. OATD went live on 1 April 2013. It receives support from the Z. Smith

Reynolds Library at Wake Forest University, North Carolina, USA. As of February, 2021, there were about 5,307,094 theses and dissertations indexed in this resource [108].

3.6. Networked Digital Library of Theses and Dissertations NDLTD

The NDLTD is an international organisation dedicated to promote the adoption, creation, use, preservation and dissemination of Electronic Theses and Dissertations (ETD). It was launched in 1996, with combined efforts of over 120 universities from around the world. As of February 2021, the NDLTD [109] provides access to a collection of 5,991,186 ETDs.

3.7. Comparative studies of open access repositories

From a comparative perspective, it is useful to examine the findings of Lee-Hwa et al. [55] on open access digital repositories in Southeast Asia, using data obtained from OpenDOAR, ROAR and the Ranking Web of World Repositories (RWWR). Specifically, in 2011, they researched repositories in countries belonging to the Association of South East Asian Nations (ASEAN). At that time, of the 51 total ASEAN repositories, Indonesia was the largest contributor at 39%, followed by Malaysia (33%) and Thailand (13%). The authors concluded that 'In general, the trend of repositories for ASEAN countries was quite similar to the trends of world repositories, where there was a rapid increase in the number of repositories in recent years (p. 283)'. However, their key message was that despite the overall increase in numbers, these countries ranked very poorly in terms of the visibility of their repositories. As a result, they were not maximising the benefits of open access; authors, for example, would not be gaining the recognition which they deserved.

Another useful comparative study is that of Moskovkin et al. [12], in which the researchers analysed important international open access sources, including ROAR, OpenDOAR, DOAJ and ROARMAP, to develop an index of countries' involvement in the Open Access movement. Their research included 'developed countries (USA, UK, Germany, etc.), developing countries (Indonesia, Brasil, India, Turkey, etc.), and countries with transition economies (Russia, Ukraine, Poland, etc.)' . They reported that in 2019, 20% of the participating countries (34 countries) accounted for 85.5% of the total number of open access initiatives and open access instruments, and developing countries such as Indonesia, Brazil, India and Turkey had done a noteworthy job of integrating into the international open access movement. However, most of the countries worldwide, especially in non-developed countries, scored quite poorly. This was, in part, because an institution might have developed a digital repository, for example, but had neither developed open access mandates and/or policies nor encouraged its researchers to publish in open access journals. In short, the uptake of open access was quite limited.

4. Discussion

The purpose of this study was to analyse the adoption of the open access movement worldwide and to identify those factors which are slowing the progress within developing countries. From the results analysed above, it can be seen that an overall steady increase in the uptake of the major open access platforms does not present a complete view of progress by individual institutions. In this section, the researchers have organised their discussion of these results based on the four research objectives.

4.1. Major benefits of open access to scholarly communication

The researchers have identified the following main advantages of supporting the open access movement:

- Wider access to publicly funded scientific research.
- Increased and wider readership of research content in general.
- Accelerated scientific communication with the potential for maximising new discoveries and innovation.
- Increased citations for authors.
- Partial solution for libraries for so-called crises of 'price and permission' [56].

Of particular relevance to developing countries are those aspects which enhance the visibility of their research outputs. These include, but are not limited to, helping to bridge the digital divide through minimising access and knowledge issues. At the same time, through open access, researchers in these countries can interact with key research from other countries, whose access would normally be limited by copyright, licencing and/or subscription restrictions. Unsurprisingly, as concluded by Moskovkin et al. [12], 'scientists from low-income countries are more motivated to publish their articles in Open Access journals or platforms than scientists from high-income countries'.

4.2. Adoption of the open access model worldwide

This current review of literature and data from key open access resources indicates that the open access movement not only has been steadily gaining acceptance worldwide but also – and perhaps more importantly – is continuing to provide access to valuable research outputs [110]. The recent global pandemic has reinforced this concept [111]. However, despite these findings, the data have also highlighted that, in general, the progress in developing countries within geographical areas such as Africa, Asia and Oceania is quite a bit slower. This rate of adoption supports studies by Cortegiani et al. [77] and Moskovkin et al. [12].

4.3. Major factors which are adversely affecting the uptake of open access, particularly in developing countries

Based on the findings, there would appear to be a disconnect between the desire of researchers in developing countries to benefit from publishing in open access resources and the rate at which those countries are able to provide the appropriate resources. While Moskovkin et al. [12] have discussed the high rates of motivation in these countries, Ukwoma and Onyebinama [97], on the other, have reported on the difficulties faced by federal and state universities in Nigeria, for example, in providing researchers with required open access resources.

In addition, in some developing countries, the greatest number of open access journals is, in fact, produced by predatory publishers [57]. These can be attractive as research outlets for those researchers who are required to publish in 'international' journals, for example, despite their lack of academic rigour. Unfortunately, as Memon [68] has observed, researchers from developing countries are the most likely targets, given their general insufficient training and knowledge of publishing practices.

At the same time, there is the opposite challenge in which legitimate open access sources are not listed as 'approved' in those countries, for example, Pakistan and India, which produce national lists of approved journals (University Grants Commission – Consortium for Academic and Research [112,113].

From a financial perspective, fees such as APCs can present a serious hurdle, even with automatic partial waivers by some journals for low-income countries. Jain et al. [87] and Nabyonga-Orem et al. [86] have outlined the challenges in their respective countries for researchers to access funding to pay for APCs. Moreover, given already limited resources in institutions which seldom allocate funding towards publishing fees, researchers must cover key costs, such as staff, equipment and field work [83]. This then limits the publishing opportunities for these researchers.

As documented earlier in this study, another limiting factor is the concern regarding a potential loss of international reputation by publishing with an open access provider rather than with a more traditional publisher [94]. This highlights the role that an institutional open access policy and/or mandate can play in helping to drive the adoption of open access within an institution [12]. While the data reported from ROARMAP show a steady increase in the growth of open access mandates and policies adopted by universities, research institutions and research funders worldwide, countries within Asia, Oceania and Africa are lagging significantly behind Europe and the Americas. These results corroborate the findings of Moskovkin et al. [12].

4.4. Library strategies to increase the uptake of the open access model within developing countries

Given that libraries play a fundamental role in connecting users with information, it is logical that they would have a vested interest in supporting open access. However, not all libraries, especially those in developing countries, have yet to take an active part in promoting open access to their users [47,98]. Therefore, there is considerable groundwork which the library can undertake within their parent organisation to overcome misconceptions about open access and to build informed awareness.

In addition, within universities and research organisations, libraries are key partners with other stakeholders in providing researchers with support throughout the research lifecycle, beyond just providing access to scholarly content [98,114]. For these institutions, mandates from national research funding agencies as well as internal standards for the conduct of responsible research have identified data as a critical research output [115]. This recognition of the importance of data has led to growing international pressure to develop a sustainable approach to ensure rapid open access to the world's research outputs. Libraries have joined with other organisations to advance open and F.A.I.R. (Findable, Accessible, Interoperable, and Reusable) access to research outputs, including data [115]. While these initiatives are instrumental in helping to drive the adoption of open access within institutions, developing countries have not yet engaged with them at the same level as developed countries.

Given that, as reported in this study, major impediments to engagement in these countries are frequently based on financial and other resource constraints, the authors would suggest that proposed library strategies need to be practicable and feasible. An important starting point is working with other research support stakeholders within the organisation to create awareness and thereby build a change in culture and practice. As a corollary, a logical next step is to then facilitate the development of an institutional open access mandate and related policies.

The challenge of addressing the financial burden of APCs is more complex, as it is based on extra-institutional drivers. While the library can raise awareness within the organisation and help to promote a coordinated approach to APC funding, addressing the larger challenge requires a different approach. Libraries in a developing country may need to consider adopting a similar approach to that of the use of consortia in developed countries. The objective would be to leverage consortia purchasing power to influence publishers.

5. Conclusion and recommendations

The open access movement is an important, relatively recent development in scholarly publishing. Considering current challenges faced by researchers in developing countries, it offers some attractive benefits which help bridge the gap between access and research content. However, the adoption of open access, especially within these geographical areas, is not without its challenges. This study concludes that key stakeholders, such as libraries, can draw upon their expertise to help drive the adoption of open access within institutions in these countries.

Because the library provides targeted services to support researchers throughout the research lifecycle, it is important that it takes a proactive role in working with other institutional stakeholders to address relevant issues. The latter may be based on the lack of key enabling resources, for example, financial, infrastructure, technical skills and relevant mandates and/or policies. In addition, libraries have an important role in ensuring that important extra-institutional entities, for example, research funders and relevant government policy makers, are made aware of the issues that have been outlined in this study.

Based on the results of this study, the authors propose that libraries consider the following recommendations to address the challenges identified in this article.

5.1. Identification of a developing country's progress in the open access movement

As a starting point, the authors suggest that interested libraries in developing countries consult the appendix created by Moskovkin et al. [12], which quantifies the involvement of countries worldwide in the open access movement. Two key criteria are the number of open access journals listed in DOAJ and the number of open access repositories listed in either the ROAR or OpenDOAR registries. These are areas in which the library can work with other organisational stakeholders to seek funding to build supporting infrastructure and to improve low levels of engagement, as applicable.

5.2. Creating awareness within the parent organization

Some of the challenges which academic and research libraries, in particular, may face within their institution include a resistance from the user community because of misconceptions about open access as well as a lack of awareness and/or support from senior management within the parent organisation. While these challenges are not insignificant, there are useful strategies for addressing them. The authors have drawn principally upon recommendations found in the literature that underpins library research support. Recommendations for challenges arising in that area tend to include solutions that involve the library working with other stakeholders, rather than by itself. We felt that this approach was equally applicable in the case of open access.

Examples of strategies include the following:

- Finding well-respected academics/researchers to help 'champion' open access within the institution [116,117].
- Working closely with other organisational support stakeholders, such as Research Offices, to not only demonstrate the advantages of open access but also formulate an appropriate open access policy for the institution. The latter will help to provide the credibility needed to effect a change in organisational culture and practice [118,119].
- Taking the lead in developing a coordinated approach within the organisation regarding the funding for APC charges [27].
- Working closely with the organisation's information technology division to establish and actively promote an institutional repository for supporting open access to the organisation's own research outputs [85,114].

- Working with the organisation's information technology division and other stakeholders to identify any relevant technical skills shortages and establish ways to address them [118,120,121].
- Enlisting the assistance of external bodies, such as a national library association or funding agency, to build awareness among both the researcher community and senior management of how open access helps drive future research and innovation [122].

Finally, in looking towards the future, Open Access is part of a much bigger landscape which encompasses concepts such as Open Science, Open Research and Open Scholarship. In the longer term, libraries need to move from just advising their clients about 'publishing in open access sources' to building an understanding of how 'openness' can be embedded more widely within culture and practice.

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